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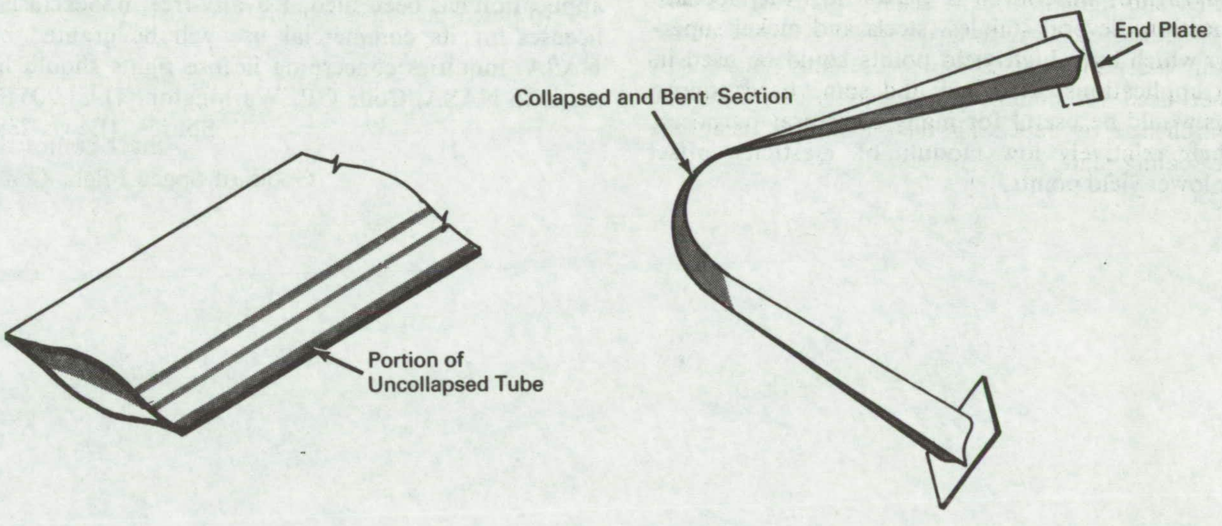
NASA TECH BRIEF

Metal Tube Can Be Folded for Compact Stowage, Is Self-Erecting



The problem:

To design a metal tube that can be safely bent into a coil for stowage in limited space and readily released to serve as a rigid fluid transportation conduit or structural member. Several designs which were considered were found to have serious limitations. A metal tube with telescoping segments would pose a problem of maintaining the integrity of movable seals at the joints under adverse fluid flow conditions. A metal tube of circular cross section would permit only a small angle change per unit length. Therefore for the large angular deflections necessary to bend the tube into several loops without causing permanent deformation, the tube would be excessively long and heavy. Although a metal tube, made in the form of a thin-walled bellows would be flexible and relatively light, its convolutions would tend to trap liquid and cause a high frictional pressure drop. In addition, an auxiliary structure would be required to maintain the bellows in a rigid condition during service.

The solution:

A tube configuration that permits reducing the section modulus to that of a thin plate, thus permitting the section to be bent as a flat plate without destructive yielding of the material.

How it's done:

The tube in the unstressed or operating condition is comprised of two segments having a cross section defined by opposing circular arcs. The arcs have essentially equal radii and terminate tangentially in the same plane. The tangential edges are secured by welding or other conventional joining methods. Plates are welded to the ends of the tube to maintain their cross sectional shape when the center is collapsed. When the tube is collapsed, it can be sharply bent or rolled into

(continued overleaf)

a coil. Upon release of the restraining force, the tube will automatically resume its original configuration to serve as a conduit for transporting fluid or as a rigid structural member. A tube of this design can be fully collapsed and bent to a radius as small as 1.84 inches ($t/r = 0.011$, where t is the material thickness and r is the radius of curvature) without damage.

In selecting a metal for a specific application, both the chemical and physical characteristics of the environment in which the tube is to be used must be considered. A high yield point and a low modulus of elasticity are usually desirable in order to maximize the permissible strain, since yield strain is the ratio of yield stress to modulus of elasticity. Selecting a material with these characteristics maximizes the ratio t/r and permits a thicker material or a smaller radius of curvature, whichever is better for the specific application. Several stainless steels and nickel superalloys which have high yield points could be used in most applications. Titanium and some hard copper alloys would be useful for many structural purposes, as their relatively low moduli of elasticity offset their lower yield points.

Note:

Further information concerning this invention is given in NASA TM X-1187, "Evaluation of One Type of Foldable Tube" by Laurence W. Gertsma, James H. Dunn, and Erwin E. Kempke, Jr., December 1965, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151. Inquiries may also be directed to:

Technology Utilization Officer
Lewis Research Center
2100 Brookpark Road
Cleveland, Ohio 44135
Reference: B66-10450

Patent status:

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